Alternative Fuels Combustion Products

Subcontractor

Southwest Research Institute

Principle Investigator

Kevin Whitney
Southwest Research Institute
6220 Culebra Road
P.O. Drawer 28510
San Antonio, TX 78228-0510
(210) 522-5869

DOE Project Manager

Michael Gurevich
U.S. Department of Energy
CE-332, MS 6A-116/Forrestal
1000 Independence Avenue, SW
Washington, DC 20585
(202) 586-6104

NREL Technical Monitor

Brent Bailey
NREL
1617 Cole Boulevard
Golden, CO 80401
(303) 275-4468

Subcontract Number

YAE-3-13253-01

Performance Period

9/93–2/96

NREL Subcontract Administrator

Scott Montgomery (303) 275-3193

Objective

- Identify volatile organic exhaust species generated from alternative-fueled light-duty vehicles operating over the Federal Test Procedure (FTP) on compressed natural gas (CNG), liquefied petroleum gas (LPG), methanol (MeOH), ethanol (EtOH), and reformulated gasoline (RFG)
- Determine the effects of simulated vehicle failure modes on exhaust emissions from these fuels
- Determine the influence of a catalytic converter on exhaust species formation while operating on alternative fuels.
- Determine atmospheric reactivity of vehicle exhaust emissions while operating on these alternative fuels

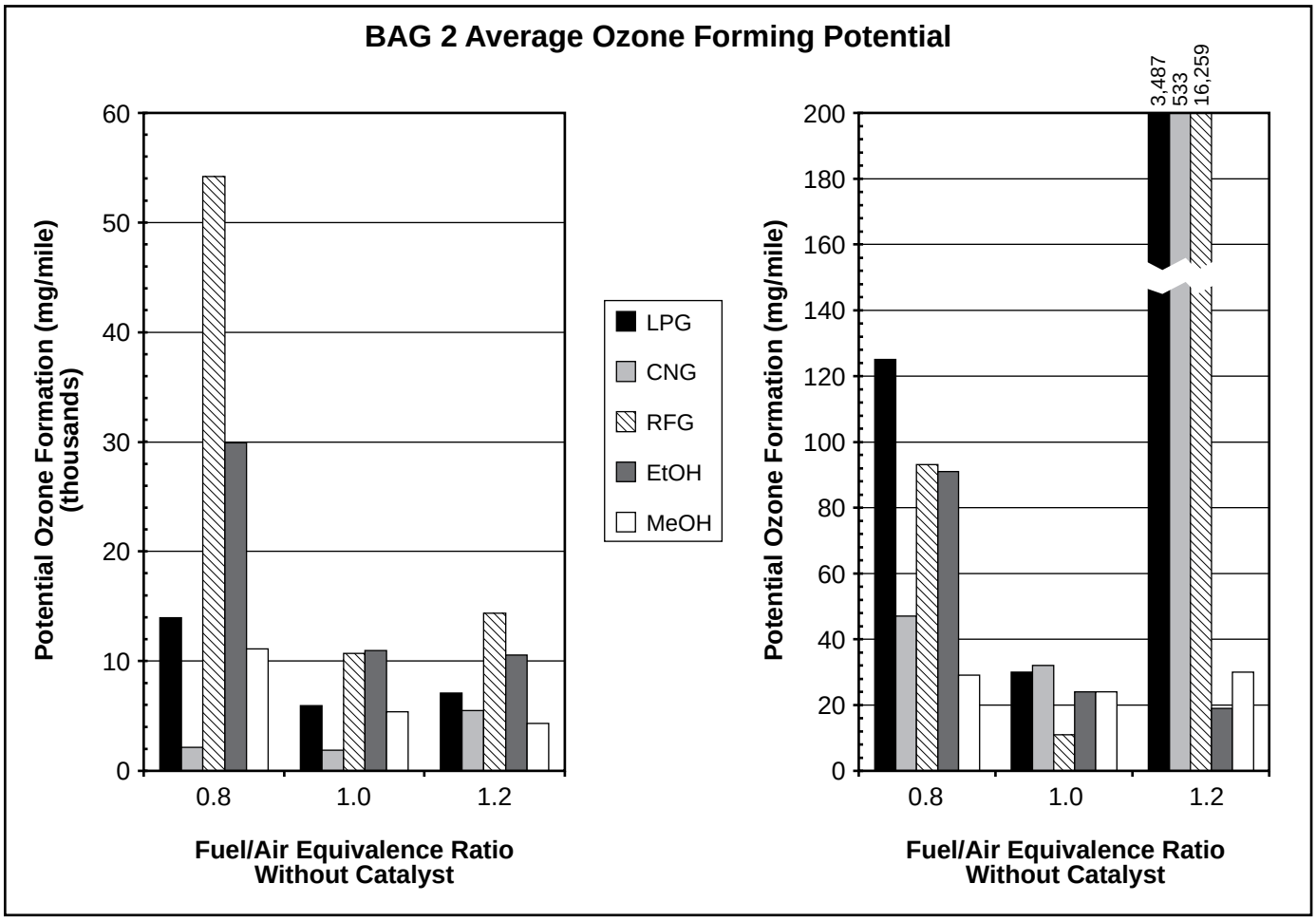
Vehicle being tested on chassis dynamometer

Approach

Experiments were conducted using two vehicles, one modified to operate on gaseous fuels and one modified to operate on alcohol fuels. Both vehicles were operated over the chassis dynamometer portion of the FTP for light-duty vehicles. Sampling and analyses of exhaust samples determined (1) regulated exhaust emissions by CFR methods, hydrocarbon speciation, and aldehyde and ketone analyses according to Auto/Oil Phase II methods, and (2) trace exhaust species by mass spectral analysis methods. A comparison of the three fuels' ozone-forming potential was made based on the Maximum Incremental Reactivity (MIR) scale used by the California Air Resources Board (CARB).

Accomplishments

Tests conducted with CNG and LPG indicated emissions of non-methane organic gases (NMOG) and toxics while operating on these fuels were significantly lower than with RFG. Because of the extremely low volatility of EtOH and MeOH, cold-start vehicle driveability was poor during tests conducted on these fuels. This resulted in higher exhaust emissions compared to RFG. When comparing NMOG exhaust emissions generated during



the warm, stabilized portion of the FTP, the general trend was CNG ≈ MeOH < LPG < EtOH ≈ RFG. Speciation data indicated that exhaust components from the four alternative fuels were primarily C1 to C3 compounds. The reactivity of the fuels followed the following trend: MeOH < LPG ≈ CNG < EtOH << RFG. However, the measured ozone-forming potential from these fuels was of a similar level for a fully-warmed, catalyzed vehicle. Mass spectral analysis identified a number of nitrogen-containing compounds in exhaust samples from all fuels, including nitromethane, nitroethane, and nitropropane.

Future Direction

This program evaluate exhaust emissions from a vehicle operating on butane fuel blends, analyze a controlled vacuum insulated catalyst system for an ethanol-fueled vehicle, and measure small particulate matter emissions from a vehicle operating on alternative fuels in a simulated rich-failure mode.

Publication

Whitney, K. and Bailey, B. (1994). "Determination of Combustion Products from Alternative Fuels, Part 1: LPG and CNG Combustion Products," SAE Paper 941903.